ESA Solar Orbiter Remote Sensing Payload Working Group

Kick-Off Meeting – 16/17 May 2002

Draft Notes – Richard A. Harrison

This note outlines the main points of the ESA Solar Orbiter Remote Sensing Working Group meeting of 16/17 May 2002, which was held at ESTEC. It outlines the basic approach for our study and contains the first draft of the list of 'challenges', which we compiled. Note that the final section lists actions which are to be tackled in the immediate aftermath of the meeting!

1. Basic Approach of Working Group

- List the instruments to consider - including any additional instruments which we feel should be included.
- Consider each instrument in turn and list the challenging/problem areas.
- List any mission/operational challenges/problems.
- Classify the resulting list of challenges/problems into the following categories:
  - (i) 'Global' (mission/operatonal) challenges (e.g. pointing);
  - (ii) Multi-instrument challenges (e.g. detectors);
  - (iii) Instrument-specific challenges which are potential show-stoppers, and
  - (iv) Other instrument-specific challenges.
- We ignore category (iv) (this is for the proposing teams!) and act upon the others.
- Assess the resulting lists and assign studies or define test activities to be done.

2. List of Instruments

2.1 Strawman Instruments

VIM – Visible Light Imager and Magnetograph
EUS – EUV Imaging Spectrometer
EUI – EUV Imager
UVC – UV and Visible Coronagraph
RAD – Radiometer

2.2 Additional Instruments to be considered

High Energy (X-ray/gamma-ray) imager
X-ray High Temperature Imaging Spectrometer (<10^7K)
Heliospheric Imager

3. List of Instrument Challenges/Problems

3.1 ALL INSTRUMENTS

3.1.1 A thorough study of the thermal feasibility of each instrument is required, probably including modelling and test activities in some cases. In particular, it must assess the thermal balance, the impact of the orbital variations to the thermal input and the impact of (and ways to cope with) degradation/aging of the reflectivity of the optical systems. An estimate of the radiator size requirements must be made. *Category (iii).*

3.1.2 The thermal 'regulation', during the orbit, of each instrument must be considered, for example, using regulating radiators (e.g. cut/limit the radiators at/near aphelion) or switchable heatpipes, to damp the extremes in the variability. This must be studied to demonstrate that we can cope with a heat load varying by a factor of 25. *Category (iii).*

3.1.3 A realistic study is required to show that the scientific operation of each instrument is not compromised by the limited telemetry rate. *Category (iii).*

3.1.4 A realistic study of the instrument mass of each instrument is required. *Category (iii).*

3.1.5 A realistic study of the instrument power of each instrument is required. *Category (iii).*

3.2 VIM

3.2.1 Can the proposed camera system cope with the perceived particle environment? See detector section below. *Category (ii).*

3.2.2 Can we demonstrate that electro-optically modulated liquid crystal devices are not influenced by the particle and thermal environment? *Category (ii).* [with UVC].

3.2.3 VIM carries a sensor used for image stabilisation. It is suggested (below) that this be used as the image stabilisation signal for all instruments requiring stabilisation – to save mass by avoiding duplication. *Category (i).*

3.2.4 For the thermal and particle extremes which Orbiter will encounter, how do we guarantee the required levels of cleanliness in VIM? *Category (ii).*

3.2.5 For VIM, a light-weight mirror is required. Is the technology available, or on the horizon for such a mirror? *Category (iii).*

3.2.6 Is it feasible to include a front filter on VIM? *Category (iii).*

3.3 EUS

3.3.1 The question of contamination and subsequent degradation of the optical systems must be considered, especially in the extreme thermal and particle environment. Consider tests which could be performed as well as outgassing policies etc… *Category (ii).*

3.3.2 If we remove the independent pointing capability, can we include a method for image alignment? This is a general question for several instruments to ensure co-pointing. *Category (ii).*

3.3.3 Can we assess the integrity of multilayers at high temperatures including a definition of tests to be done. *Category (ii).*

3.3.4 Can we demonstrate that 5 micron 4kx4k APS, visibly blind detector systems are likely to be possible for such an instrument? *Category (iii) but see detector section below.*

3.3.5 There is some concern over the impact of the particle environment on optical coatings in the light of studies of hydrogen bubbles forming under gold coatings in the solar wind. This must be assessed. *Category (ii).*

3.3.6 The strawman EUS is too long. Can we demonstrate that a shorter instrument is possible. *Category (iii).*

3.3. EUI

Note: Alan and Don – produce definitive list of questions for EUI…

3.3.1 The instrument will most likely include multilayers. Can we assess the integrity of multilayers at high temperatures including a definition of tests to be done. *Category (ii).*

3.3.2 The proposed EUI is too long. However, the current HRI baffle system is not long enough! Can we demonstrate that a shorter instrument is feasible? *Category (iii).*

3.3.3 The FSI filter sees full Sun. This will, most likely, not survive at 25 solar constants. We must assess and cater for this. *Category (iii).*

3.3.4 Must assess the most realistic detector option given the particle environment. See detector discussion below. *Category (ii).*

3.4 UVC

3.4.1 With a common pointing policy, UVC must be able to cope with likely offsets. Assess this. *Category (iii).*

3.4.2 We must assess the integrity of the liquid crystal device in the particle/thermal environment. *Category (ii) [with VIM].*

3.4.3 The instrument will most likely include multilayers and, thus, a consideration and test of multilayers at high temperatures is required. See EUS and EUI. *Category (ii).*

3.4.4 The best options for detectors must be assessed, given the particle environment. See detector discussion below. *Category (ii).*

3.5 RAD

Note: Thierry to produce the list. Need list of issues/challenges.

3.6 Heliospheric Imager

Note: Clarence to contact Bernie and to take lead on this. Need list of issues/challenges.

3.7 High Energy Imager (Hard X-ray)

Note: STIX presentation given by Gordon Hurford – ideal link from particles at Sun (flares) and in-situ, with gamma-ray spectrometer.

Note: Gordon to list issues/concerns.

3.7.1 One area of concern is the STIX CCD which would probably not be the best option at 0.2 AU. Assess this. *Category (iii).*

3.8 Grazing Incidence X-ray/EUV Coronal Imaging Spectrometer

Note: Discussion presented by Luca (see Tenerife abstracts). General conclusion was that this is an option within EUS rather than a separate instrument.

3.9 GENERAL REQUESTS FROM SPACECRAFT STUDY

3.9.1 Can we assess the possibility for a payload mass increase? *Category (ii).*

3.9.2 Can we assess the possibility for a payload telemetry increase? *Category (ii).*

3.9.3 Can we assess the possibility for a payload power increase? *Category (ii).*

4. List of Mission/Spacecraft/Operational/Multi-instrument Challenges/Problems

4.1 Pointing

It is proposed that the instruments are hard-mounted to the spacecraft and that we have a co-pointing policy. This is in keeping with a co-ordinated JOP/pointing scenario. It is recognised that this can save mass, power and will simplify operations.

4.1.1 Assess this option for UVC – how do we compensate for this? UVC will need some adjustment. *Category (iii).*

4.1.2 How do we cope with alignment – some method is required to ensure that we have aligned fields. Does this simply require large areas or some mechanisms? *Category (i).*

Recommend that we adopt a hard-mounted, joint pointing policy, which is in keeping with the science goals but will save mass, power etc…

4.2 Detectors

It is recognised that we must demonstrate feasibility, rather than select the 'final' detector system. It is noted that the demands on small pixels (down to 5 microns), array sizes (up to 4kx4k), mass, and the particle environment may be very restricting to CCD systems and this suggests that APS and Diamond detectors are appropriate. The different advantages of these two are noted but some areas require study, assessments and tests.

4.2.1. Assess the status of the APS and Diamond systems regarding the requirements for Orbiter. Does this require some technological activity funded by ESA? *Category (ii).*

4.2.2. Can we demonstrate that an APS system can be EUV sensitive (and rad-hard?) in good time for Orbiter? Should some development work be requested? *Category (ii).*

4.2.3. Can we characterise the expected particle environment at 0.2 AU, including solar wind flux, flare/CME/shock accelerated particles, cosmic rays and neutrons? In particular, the anticipated neutron environment is of concern. Assess the impact of this on the APS and Diamond systems. *Category (ii).*

4.3 Image Stabilisation

4.3.1 For image stabilisation – best to use signal from only one source, i.e. the VIM. We must assess this option fully. *Category (ii).*

Recommend that we use the VIM signal for all instruments that use an image stabilisation system. Will save mass – i.e. no duplication.

4.4 On-board Intelligent Operation

Can we have on-board target recognition for autonomous target selection? Note that this will most likely drive pointing of spacecraft (given above recommendation).

4.4.1 Initiate target recognition, automated pointing study to assess fully how we cope with this for Orbiter. List what targets could be selected and the responses. What timing

constraints exist for what targets? What mode changes could be envisaged? Will require image/data on board inspection and reaction. *Category (i).*

4.5 Operations Planning

Treat the mission as an encounter mission with a 149 day planning cycle. Organise the encounter periods using JOP selections for the passes. Selection of some targets can be done well ahead of time and updated nearer to pass. Some targets need intelligent selection.

4.5.1 Assess the operations scenario based on this encounter mission scenario? *Category (i).*

4.6 Instrument Safing

4.6.1 What are the hazards for each instrument and how should the instrument respond? Include an assessment of transferring data to warn other instruments that do not have access to such data (e.g. warning UVC of a flare). Include assessment of flare/particle storm impact and spacecraft emergency. Include thermal impact of closing doors. *Category (ii).*

5. <u>ACTIONS! - Next Steps – Is everything on the list?</u>

The following people are to co-ordinate a final check on the list within the interested groups to ensure that everything that should be listed is indeed listed:

VIM – Valentin
EUS – Richard
EUI – Don/Alan
UVC – Silvano
RAD – Thierry

High Energy Imager – Gordon
Heliospheric Imager – Clarence

Global/Mission Issues – Co-Chairs

Immediate Schedule of Actions:

- Draft list from co-chairs to all by May 24.
- Response from the above people by mid-June to confirm that list is complete.
- Co-Chairs to discuss assignments of the tasks and the communication of the group over the coming months.
- Co-chairs to fix mid-term meeting.

[R.A. Harrison & B.Fleck - May 17 2002]